

CLAIMS

1. An electric cylinder comprising:

two kinds of nuts of a ball thread nut in which a thread groove in an arc shape in section is formed and a non-ball thread nut which is rotatable in synchronization with the ball thread nut and in which a thread groove in a rectangular or trapezoidal shape in section is formed; and

a thread rod inserted through the two kinds of nuts,

wherein in the thread rod is a double-start thread in which the two kinds of thread grooves are formed at the same pitch, the thread grooves including a thread groove in an arc shape in section meshed with the ball thread nut through balls and a thread groove in a rectangular or trapezoidal shape in section meshed with the non-bal thread nut, and

the electric cylinder is so composed that:

when load working in the axial direction on the thread rod is less than a predetermined value, a thread ridge of the non-ball thread nut and a thread ridge of the thread rod are separated and are out of contact with each other so that the thread rod is moved in the axial direction thereof by only the ball thread nut, and

when the load working in the axial direction on the thread rod exceeds the predetermined value, the thread ridge of the non-ball thread nut and the thread ridge of the thread rod are made in contact with each other so that the thread rod is moved in the axial direction thereof by the non-ball thread nut.

2. An electric cylinder comprising:

two kinds of nuts of a ball thread nut in which a thread groove in an arc shape in section is formed and a non-ball thread nut which is rotatable in synchronization with the ball thread nut and in which a thread groove in a rectangular or trapezoidal shape in section is formed; and

a thread rod as a single-start thread including a ball thread portion in which only a

thread groove in an arc shape in section meshed with the ball thread nut through balls is formed and a non-ball thread portion in which only a thread groove in a rectangular or trapezoidal shape in section meshed with the non-ball thread portion is formed, the ball thread portion and the non-ball thread portion being formed separately in the axial
5 direction,

wherein the electric cylinder is so composed that:

when load working in the axial direction on the thread rod is less than a predetermined value, a thread ridge of the non-ball thread nut and a thread ridge of the thread rod are separated and are out of contact with each other so that the thread rod is
10 moved in the axial direction thereof by only the ball thread nut, and

when the load working in the axial direction on the thread rod exceeds the predetermined value, the thread ridge of the non-ball thread nut and the thread ridge of the thread rod are made in contact with each other so that the thread rod is moved in the axial direction thereof by the non-ball thread nut.

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3. An electric cylinder comprising:

two kinds of nuts of a ball thread nut in which a thread groove in an arc shape in section is formed and a non-ball thread nut which is rotatable in synchronization with the ball thread nut and in which a thread groove in a rectangular or trapezoidal shape in section
20 is formed; and

a plurality of thread rods arranged in parallel to each other,

wherein only a thread groove in an arc shape in section meshed with the ball thread nut through balls is formed in each of some of the plural thread rods while only a thread groove in a rectangular or trapezoidal shape in section meshed with the non-ball thread nut
25 is formed in each of the other thread rod, and

the electric cylinder is so composed that:

when load working in the axial direction on the thread rods is less than a

predetermined value, a thread ridge of the non-ball thread nut and each thread ridge of corresponding thread rods are separated and are out of contact with each other so that each of the thread rods is moved in the axial direction thereof by only the ball thread nut, and

when the load working in the axial direction on the thread rods exceeds the
5 predetermined value, the thread ridge of the non-ball thread nut and each thread ridge of the corresponding thread rods are made in contact with each other so that each of the thread rods is moved in the axial direction thereof by the non-ball thread nut.

4. The electric cylinder of any one of Claims 1 to 3,

10 wherein a width of the thread ridge of the non-ball thread nut is set smaller than a width of the thread groove for the non-ball thread nut of each thread rod so that a state is controllable and exchangeable between a state that the thread ridge of the non-ball thread nut is separated from the thread ridge of each thread rod and a state that they are in contact with each other.

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5. The electric cylinder of Claim 4, further comprising:

a mating clutch for connecting the ball thread nut and the non-ball thread nut so that the ball thread nut is moved in the axial direction with respect to the non-ball thread nut while one of the ball thread nut and the non-ball thread nut rotates in synchronization
20 with rotation of the other.

6. The electric cylinder of Claim 4, further comprising:

a servo mechanism for controlling and exchanging the state between the state that the thread ridge of the non-ball thread nut is separated from the thread ridge of each thread
25 rod and the state that they are in contact with each other, the servo mechanism including:

a main servo motor for rotating the ball thread nut;

a sub-servo motor for rotating the non-ball thread nut;

a servo amplifier for performing speed control with respect to the main servo motor that rotates the ball thread nut; and

another servo amplifier which receives a signal from the main servo motor to allow the sub-servo motor to follow the main servo motor and which performs position control so that the sub-servo motor is displaced with respect to the main servo motor according to load of the main servo motor and so that the displacement of the sub-servo motor with respect to the main servo motor is withdrawn according to the load of the sub servo motor.

10 7. The electric cylinder of any one of Claims 4 to 6,

wherein the ball thread nut is supported to a main body by means of a sleeve urged in the axial direction by a spring movably in the axial direction together with each thread rod according to load in the axial direction working on the ball thread nut, and

15 the non-ball thread nut is supported and fixed in the axial direction to the main body so that the thread ridge of the non-ball thread nut is separated from or in contact with the thread ridge in a rectangular or trapezoidal shape in section of the corresponding thread rod by movement in the axial direction of each thread rod.